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DICHOPHYLLUM MOOREI AND CERTAIN ASSOCIATED SEEDS

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A few years ago Elias (Moore et al., '36) described a flora from the Upper Carboniferous of east-central Kansas which contained certain elements such as *Walchia* and *Taeniopteris*, plants generally accepted as more typical of higher horizons. In many ways the most interesting and certainly the most novel member of the flora is the plant described as *Dichophyllum Moorei* (fig. 1). In the hope that a more detailed knowledge of it might shed light on the general problem of leaf morphology in the seed plants we visited the type locality in the summer of 1939 and made a small collection. Excavations carried on during the following summer yielded some excellent specimens, and although much remains to be known about this interesting fossil sufficient information has been obtained to warrant a short note on its gross morphology.

Occurrence of the Fossils.—

The locality from which both Elias' and our own specimens were obtained lies about six miles northwest of Garnett, Kansas (Section 32, T. 19S, R. 19E), which is in the Victory Junction member of the Stanton limestone and of Upper Carboniferous age. Its stratigraphy has been carefully worked out (Moore et al., '36), and despite the Permian aspect of the flora there seems to be no doubt that its age as given is correct.

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Some difficulty attended collecting due to the indisposition of the owner on whose property the original quarry is located. It was found, however, that excellent material could be obtained only a few inches below the surface of the adjoining county road less than 100 yards from the quarry. For permission to dig in the road I wish to express my appreciation to Mr. Ray Hardin, Anderson County Road Commissioner.

Dichophyllum Moorei Elias.—

The appearance of this plant may best be gained from the restoration (fig. 1), as well as figs. 2 and 3 which served as the basis for fig. 1. In the most complete specimens the main axis is observed to break up near the distal end into two or three main branches which in turn divide, ultimately resulting in two or three subdivisions or telomes. Since there is no reason to believe that we are dealing with a fern the term pinnule will not be applied to these final subdivisions. It is significant to note that the plant possesses a well-developed cuticle, a point that supports the supposed xerophytic nature of the flora and suggests gymnospermous rather than filicinean affinities. Unfortunately the cellular details of the cuticle are poorly preserved, and macerations have proven of little value.

Lateral branches may be observed in fig. 3. These start to divide almost immediately in the same dichotomous fashion as the distal branches. It has been suggested by Jongmans (Moore et al., '36, p. 16) that these specimens are referable to *Callipteris flabellifera* (Weiss) Zeiller, but Elias has pointed out that "they differ distinctly chiefly by the character of the lateral pinna; in the species from Kansas they are palmate, while in the European form they are pinnate." I am entirely in agreement with Elias in making a generic distinction between *Callipteris* and *Dichophyllum*, but I believe that our specimens of the latter clearly reveal that they are not strictly palmate but rather present a combination of pinnate and dichotomous branching. In some specimens (fig. 6) the secondary branching at first glance appears to be palmate but it is evident from figs. 3, 4 and 7 that it is more in the nature of a uniform dichotomy, with never more than two or three terminal subdivisions arranged in a strictly palmate fashion.

A comparison of the specimens illustrated here with *Callipteris flabellifera* (Gothan, in Potonié, '07) reveals a rather sharp distinction in the mode of branching of the two, the frond of the latter being pinnately divided in contrast to the pinnate-dichotomous branch system of *Dichophyllum*.

The indirect evidence available shows that there is no reason to refer this plant to the Filicineae as its supposed inclusion in the genus *Callipteris* might suggest. The rather heavy cuticle and associated seeds (p. 379) point toward a gymnospermous plant. Although a further consideration of the affinities of *Dichophyllum* must be speculative certain comparisons are not without significance.

The fossil record has supplied a wealth of evidence which indicates that the leaf of modern ferns has been derived from a branch system which became confined to a single plane and progressively webbed. It is, moreover, highly probable that such a phylogenetic trend has resulted in the typical bilobed leaf of the modern *Ginkgo*. Although it is true that a single *Ginkgo* tree may harbor much foliar variation, chiefly in the degree of dissection of the lamina, the farther back we go in geologic time the more finely divided the leaves become until they pass over imperceptibly (at least as far as this character is concerned) into typical *Baiera* species. In *Baiera spectabilis* and *B. Lindleyana,* for example, there is little left that one can call a lamina. It seems likely that here, as with the ferns, a branch system has given rise to the lamina, and it is possible that we may partially bridge the gap between the "leaves" of the above-mentioned species of *Baiera* and a branch system proper through a form such as *Dichophyllum*. It must be emphasized that the latter is not postulated as a "missing link" in a direct line of development but rather as a representative stage in the transition of side branches to a leaf-like structure composed of petiole and blade.

The morphology of *Dichophyllum* is particularly interesting in the light of Mrs. Arber's recent ('41) interpretation of leaf and stem in the angiosperms. The mode of branching that is found in *Dichophyllum* and *Psygmophyllum,* as well as certain of the better-known Coenopterid ferns, adds weight to her

conception of the *shoot* as the basic unit of plant structure. In so far as we know these forms, it is not possible to relegate their branch system to the classical categories of stem or leaf, and it is probable that the term shoot will be a generally acceptable one.

Mrs. Arber's concepts are not concerned with phylogeny. She specifically states: "This view has no phylogenetic implications; it does not commit us to any opinion as to the origin of the leaf as a matter of history, but is concerned with what the leaf actually *is*, here and now." It seems legitimate, however, to expand this concept to include certain apparent phylogenetic possibilities. A comparison of a long shoot of *Ginkgo biloba* with the shoot of *Dichophyllum* as restored in fig. 1 reveals a striking similarity in basic structure. The dichotomous side branches of the latter may well be the forerunners of the deeply dissected Baieras which in all probability are ancestral forms of the modern *Ginkgo*.

The closest affinities of *Dichophyllum* seem to lie with certain species of the genus *Psygmophyllum*, especially *P. cuneifolium*. There is, however, considerable variation in *Psygmophyllum*, and it is perhaps doubtful whether it constitutes a natural assemblage of species. Whether this be so or not the species included in that genus strongly suggest that leaves as they appear in *P. Kidstoni* may have had their origin from such forms as *P. cuneifolium*, where we find a branch system not unlike *Dichophyllum*, through *P. Grasserti* with its deeply dissected "leaves." (For a more detailed description of *Psygmophyllum* see Seward, '19, p. 79–90).

Associated Seeds.—

At least four or five species of seeds occur with the other plant remains at Garnett.[1] Of these one is of particular interest because of its abundance, its frequent association with

[1] The large number of clearly defined and apparently new seed species found here is of considerable interest. Some certainly belong to the coniferous remains, while others are probably referable to the pteridosperms or other gymnospermous groups. It is proposed to include a detailed consideration of these seeds at a later date in a general revision of American Carboniferous seed impressions and compressions.

Dichophyllum and its various features which set it apart as generically distinct from anything previously described.

The seed in question is characterized by two prominent horn-like projections at the micropylar end (figs. 8, 9, 10) and appears to be comparable with that figured by Elias as *Samaropsis* n. sp. B. However, according to the accepted concept of *Samaropsis* (Seward, '17, pp. 348–354), that genus is distinctly winged while our specimens show no semblance of a wing. Because of this disagreement and since they do not conform to any described genus it is proposed to assign to them a new binomial.

Diceratosperma Carpenteriana gen. et sp. nov.—

Samaropsis n. sp. B. Elias, in Moore, Elias and Newell, A "Permian" flora from the Pennsylvanian rocks of Kansas. Jour. Geol. **44**: 12, *fig. 7(5)*. 1936.

Seeds, presumably platyspermic, 6.0–8.0 mm. long, 3.5–4.0 mm. broad. Two prominent horns, approximately one third as long as body of seed, at micropylar end. Presence of pollen chamber indicated by papilla-like cast between horns.

Locality: six miles northwest of Garnett, Kansas: Section 32, T. 19S, R. 19E. Horizon: Victory Junction member of the Stanton Limestone, Missouri Series. Age: Upper Carboniferous. The species is named in honor of Mr. A. C. Carpenter of Ottawa, Kansas, whose knowledge of the local geology and willing cooperation greatly facilitated my collecting.

Acknowledgment.—

I am indebted to Dr. M. K. Elias for placing unpublished photographs of *Dichophyllum* at my disposal and for helpful suggestions concerning the Garnett flora.

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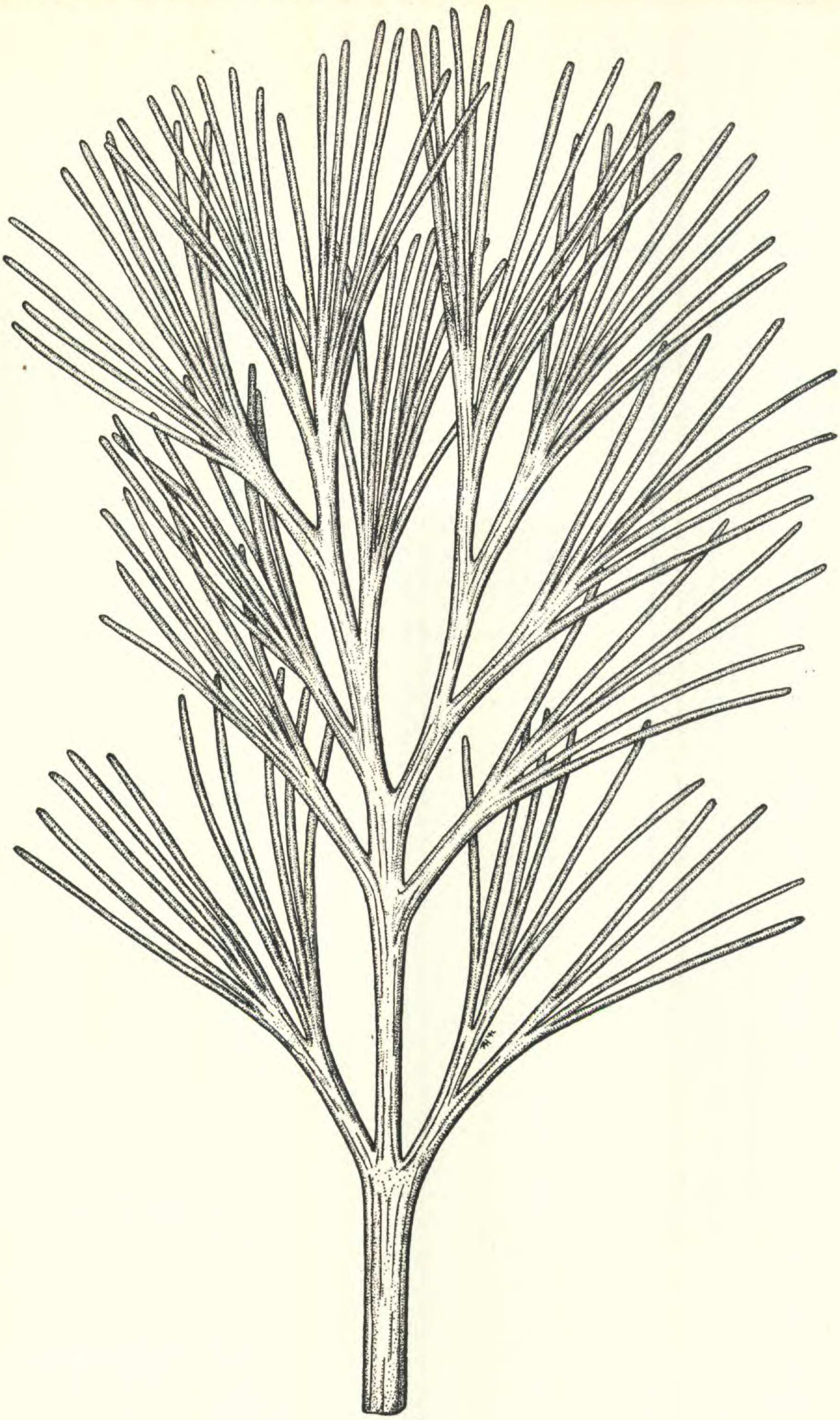
EXPLANATION OF PLATE

PLATE 13

Fig. 1. Restoration of *Dichophyllum Moorei* Elias.



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ANDREWS—DICHOPHYLLUM MOOREI

EXPLANATION OF PLATE

PLATE 14

Dichophyllum Moorei Elias

Fig. 2, No. 1432, × .5; fig. 3, No. 1433, × .5; fig. 4, No. 993, × .6; fig. 5, No. 1227, × .6; fig. 6, No. 1428, × 1.

ANDREWS—DICHOPHYLLUM MOOREI

EXPLANATION OF PLATE

PLATE 15

Fig. 7. *Dichophyllum Moorei*, No. 1425, × 1.

Figs. 8, 9, 10. *Diceratosperma Carpenteriana*, Nos. 1434, 1435, 1436 respectively, all × 6.3.